Impact of climate variability on the California Current ecosystem and Pacific salmon survival: linkages, ocean condition indicators, forecasting, and management perspectives

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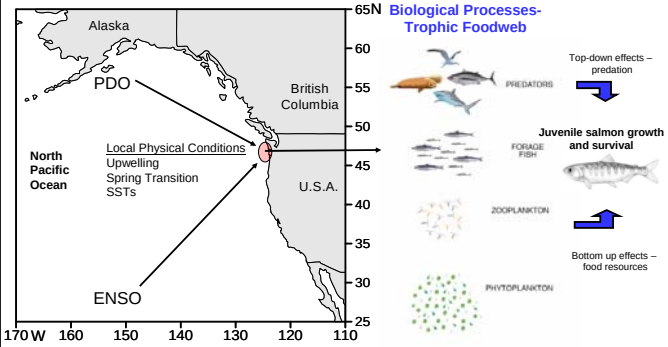
Problem Statement

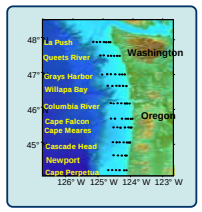
Issue - Physical and biological elements of the California Current ecosystems appear stable during each long term phase (cool or warm regime) of the Pacific Decadal Oscillation (PDO) that affects the North Pacific ecosystems

Question - If large scale regime shifts occur at a greater frequency (shorter duration), is the California Current ecosystem able to respond accordingly?

Consequence - Because Global Warming could affect duration and variability in large scale forcing; managers of fishery resources need faster responding forecasting tools!

Approach – Conceptual Model

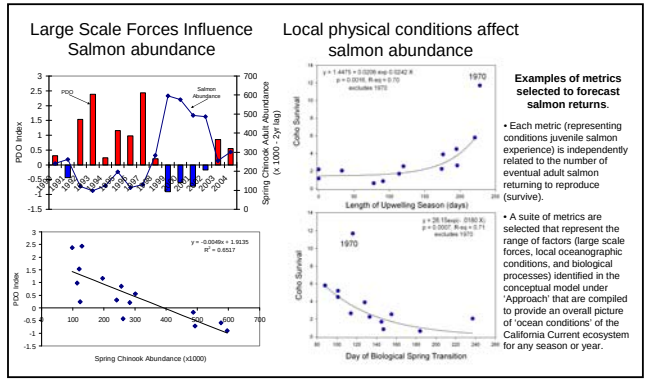




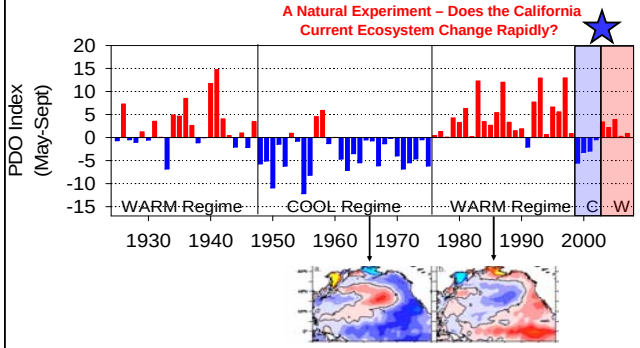
Sampling Grid

Creating an ocean condition index - Our approach is to make broad scale ecosystem observations that enable us to relate how large scale forces (PDO, ENSO) influences local physical conditions (e.g. upwelling intensity, SSTs) and biological productivity (predator abundance, forage fish abundance, zooplankton biomass) that collectively affect juvenile salmon growth and survival, setting recruitment success

Results



PDO: May-Sept Average 1925-2007

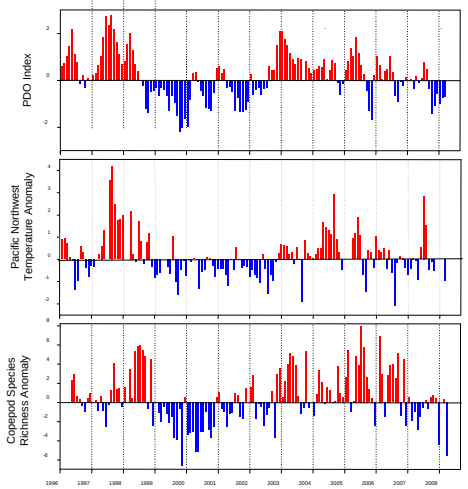


PDO Regime change in the NE Pacific Ocean historically occurred at 20 to 30 year cycles; during the cool regime, the California Current ecosystem was productive and salmon abundance high, conversely, in a warm regime, ecosystem productivity was low and salmon abundance also low.

During the past eight years, a 4 year cool regime followed by a 4 year warm regime was observed. Does the productivity of the California Current ecosystem respond at a shorter time scale and do salmon abundances respond accordingly?

Answer – The California Current Responds Rapidly to Climate Variability (Change)

Large Scale Forces (PDO) Influence Local Physical Conditions (SSTs) and Biological Productivity (Zooplankton Diversity)



PDO 1996-2008 Monthly Interval

Local California Current SSTs- 3-5 month time lag

Local Zooplankton Species Richness (Copepods) - 3-5 month time lag

Ocean Index – Forecasting Future Salmon Returns

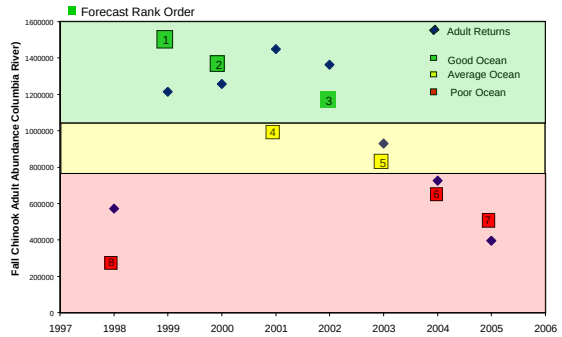
www.nwfsc.gov (look for ocean indicator link)

	Juvenile migration year				Forecast of adult returns	
	2000	2005	2006	2007	Coho 2008	Chinook 2009
Large-scale ocean and atmospheric indicators						
PDO						
MEI						
Local and regional physical indicators						
Sea surface temperature						
Coastal upwelling						
Physical spring transition						
Deep water temp. & salinity						
Local biological indicators						
Copepod biodiversity						
Northern copepod anomalies						
Biological spring transition						
Spring Chinook--June					---	
Coho--September						---

Favorable condition for salmon
Neutral condition for salmon
Unfavorable condition for salmon
High Salmon Return
Average Salmon Return
Low Salmon Return

• Ocean condition metrics rated on a green light-red light scale; the cumulative view provides a forecast of adult salmon returns 1 to 2 years into the future for fisheries managers. Each metric has been shown to independently relate to salmon survival

Salmon Abundance Forecast - Validation



• Cumulative ocean condition index predicted adult salmon abundance (survival) for the past decade